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November 20, 1992

BY MESSENGER

Ms. Donna R. Searcy, Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

Re: General Docket No. 90-314
Engineering and Technology Docket No. 92-9

Dear Ms. Searcy:

Enclosed for filing in the above-referenced dockets on behalf of American Personal Communications ("APC") are two originals and five copies of APC's Report on Spectrum Availability for Personal Communications Services Sharing the 1850-1990 MHz Band With the Private Operational Fixed Microwave Service. This study was referenced in APC's Comments filed in Docket 90-314 on November 9, 1992.

The study analyzes spectrum availability in each of the 11 largest U.S. markets under three proposed allocation plans for PCS (40, 30, and 20 MHz per licensee). The study finds that access to 40 MHz per licensee provides average spectrum availability of 25.7 MHz per licensee; that access to 30 MHz provides average spectrum availability of 19.4 MHz; and that access to 20 MHz provides average spectrum availability of only 12.9 MHz. The study also finds that 28.0 percent of all areas, on average, have no spectrum available for the implementation of PCS under a 20 MHz allocation. The percentage of area with no spectrum available for PCS falls to 17.6 percent on average under a 30 MHz allocation and to 12.3 percent on average under a 40 MHz allocation.

Please direct any inquiries concerning this matter to the undersigned.

Very truly yours,

Kurt A. Wimmer

Enclosures

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American Personal Communications

Report on Spectrum Availability

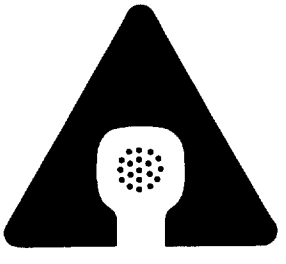
for

Personal Communication Services

Sharing the 1850-1990 MHz Band

with the

Private Operational Fixed Microwave Service



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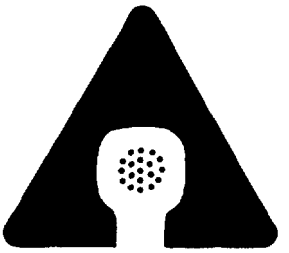

American Personal Communications

November 1992

I. Introduction

This Report on Spectrum Availability has been prepared by American Personal Communications (APC) to provide information pertinent to allocation decisions by the Federal Communications Commission (FCC) for Personal Communications Services (PCS). Specifically, this report provides data and analyses to help answer the question: How much spectrum should be allocated for each PCS licensee?

The data and analyses contained in this report are pertinent to licensed PCS services only; spectrum availability for unlicensed PCS services is not addressed.

II. July 1991 Report

In July 1991, APC completed a two volume report on spectrum sharing between PCS systems and Private Operational Fixed Microwave Service (OFS) facilities in the 1850-1990 MHz band.[1] This report was filed with APC's quarterly progress report to the FCC and was distributed to all interested parties by APC without charge. This July 1991 Report was prepared to provide factual information to answer the question: Is there enough unused spectrum in 1850-1990 MHz band to allow PCS to get started immediately using a frequency agility approach to spectrum sharing? The analysis

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[1] See Frequency Agile Sharing Technology ("FAST") Report on Spectrum Sharing In the 1850-1990 MHz Band Between Personal Communications Services and Private Operational Fixed Microwave Service, Volumes 1 and 2, July 1991. The first printing of this report did not include the "Frequency Agile Sharing Technology ("FAST")" title line. This report is referred to herein as the July 1991 Report. Since then, APC has developed the FAST System for implementing its spectrum sharing strategy and has filed a patent application to protect that technology. APC has committed to the Commission to make that technology available on reasonable terms.

of the data contained in the July 1991 Report concluded that "At least 50 MHz of spectrum is available for start-up PCS operations at the vast majority of locations in the top eleven U.S. markets."[2]

The July 1991 Report presented a detailed analysis of spectrum availability for PCS systems predicated on engineering of PCS frequency use to avoid interference to private operational fixed (OFS) microwave receivers. The report was based upon reasonable engineering assumptions about OFS facilities, PCS systems and interference protection criteria. Since the engineering assumptions were sound, the conclusions contained in the report were also sound and remain valid after a year's worth of careful scrutiny by other interested parties. The report did not provide sufficient detail for actual PCS system design in each market, nor was it intended to do so. Instead, the July 1991 Report provided valuable information for policy decisions about the PCS service.

III. FCC Actions since July 1991 Report

Since the July 1991 Report was published, the Commission has taken several steps toward the implementation of PCS in the 2 GHz band. First, the Commission issued a Policy Statement deciding generally to introduce PCS in the 1.8 - 2.2 GHz band.[3] Second, the Commission held an en banc hearing on December 5, 1991, which focused on a number of PCS issues including spectrum availability.[4] Third, the

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[2]See July 1991 Report, page 24.

[3]See Amendment of the Commission's Rules to Establish New Personal Communications Services, Policy Statement and Order, 6 F.C.C. Rcd. 6601 (1991).

[4]APC presented the results of the July 1991 Report to the Commission in connection with the hearing. See Statement of

Commission issued a Notice of Proposed Rule Making in ET Docket 92-9, proposing to allocate portions of the 1.8 - 2.2 GHz band to new technologies, including PCS, on a shared basis with existing microwave users.[5] Fourth, the Commission issued a Notice of Proposed Rule Making proposing to allocate 90 MHz of spectrum in the 1.85 - 1.99 GHz to three PCS licensees per market.[6] Finally, the Commission issued a First Report in ET Docket 92-9, deciding to adopt a transition plan under which incumbent microwave users that reliably can utilize higher microwave bands can be involuntarily relocated to suitable frequencies above 3 GHz after a "transition period" of three, eight or ten years.[7]

These actions validated the July 1991 Report's findings that sufficient available spectrum existed in the 1.85 - 1.99 GHz band to inaugurate PCS. These actions also, however, altered and made more specific the conditions under which PCS would be implemented. The July 1991 Report was

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J. Barclay Jones, American Personal Communications, PCS En Banc Hearing (Gen. Docket 90-314, Nov. 21, 1991).

[5]See Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, Notice of Proposed Rule Making, 7 F.C.C. Rcd. 1542 (1992); see also Office of Engineering & Technology, Creating New Technology Bands for Emerging Telecommunications Technology (ET Docket 92-9, OET/TS 92-1, January 1992).

[6]See Amendment of the Commission's Rules to Establish New Personal Communications Services, Notice of Proposed Rule Making, 7 F.C.C. Rcd. 5676 (1992).

[7]See Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, First Report & Order and Third Notice of Proposed Rule Making, FCC 92-437 (ET Docket 92-9, Oct. 16, 1992). The appropriate length of a "transition period" has been set out for comment. The Commission also has issued a Public Notice permitting incumbent users to add additional paths and released a Further Notice proposing a rechannelization plan for microwave bands above 3 GHz. See Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, Further Notice of Proposed Rule Making, FCC 92-357 (ET Docket 92-9, September 4, 1992).

premised on 140 MHz in the 1.85 - 1.99 GHz being made available for PCS (and APC proposed on the basis of the July 1991 Report that 50 MHz per licensee be allocated). The Commission now, however, has proposed to allocate significantly less spectrum than that to PCS. A portion of the band will be allocated to unlicensed PCS services, including Data PCS, wireless LAN and wireless PBX. The Commission also has permitted incumbent microwave users to add additional paths in the 1.85 - 1.99 GHz band and has determined that public safety microwave users will not be subject to involuntary relocation. The findings of the July 1991 Report remain as valid today as they were at the time of original publication, but each allocation option proposed by the Commission should now be analyzed in light of each specific microwave path in the major markets. This analysis is necessary to guide the Commission's determination of how much spectrum should be allocated to each PCS licensee. This Report endeavors to provide that analysis.

IV. Allocation Structures for Licensed PCS

Three specific allocation structures for PCS are examined in this report. The amount of spectrum available for licensed PCS systems under each allocation structure has been evaluated by a computer analysis described in detail below. The three allocations structures are as follows:

1. Two Licensees per Market, 40 MHz per Licensee
   (2 Lic/40 MHz)

1850 - 1870 MHz	Licensee A Subscriber Unit Transmit
1870 - 1890 MHz	Licensee B Subscriber Unit Transmit
1890 - 1910 MHz	Reserved
1910 - 1930 MHz	Unlicensed PCS
1930 - 1950 MHz	Licensee A Base Station Transmit
1950 - 1970 MHz	Licensee B Base Station Transmit
1970 - 1990 MHz	Reserved

2. Three Licensees per Market, 30 MHz per Licensee
   (3 Lic/30 MHz)

1850 - 1865 MHz	Licensee A Subscriber Unit Transmit
1865 - 1880 MHz	Licensee B Subscriber Unit Transmit
1880 - 1895 MHz	Licensee C Subscriber Unit Transmit
1895 - 1910 MHz	Reserved
1910 - 1930 MHz	Unlicensed PCS
1930 - 1945 MHz	Licensee A Base Station Transmit
1945 - 1960 MHz	Licensee B Base Station Transmit
1960 - 1975 MHz	Licensee C Base Station Transmit
1975 - 1990 MHz	Reserved

This is the allocation structure proposed in the PCS NPRM, although the subscriber unit transmit and base station transmit designations were originally reversed and then removed entirely in the Erratum released September 8, 1992.

3. Five Licensees per Market, 20 MHz per Licensee (5 Lic/20 MHz)

1850 - 1860 MHz	Licensee A Subscriber Unit Transmit
1860 - 1870 MHz	Licensee B Subscriber Unit Transmit
1870 - 1880 MHz	Licensee C Subscriber Unit Transmit
1880 - 1890 MHz	Licensee D Subscriber Unit Transmit
1890 - 1900 MHz	Licensee E Subscriber Unit Transmit
1900 - 1910 MHz	Reserved
1910 - 1930 MHz	Unlicensed PCS
1930 - 1940 MHz	Licensee A Base Station Transmit
1940 - 1950 MHz	Licensee B Base Station Transmit
1950 - 1960 MHz	Licensee C Base Station Transmit
1960 - 1970 MHz	Licensee D Base Station Transmit
1970 - 1980 MHz	Licensee E Base Station Transmit
1980 - 1990 MHz	Reserved

All three allocation structures examined in this report utilize a frequency division duplexing (FDD) architecture with a fixed 80 MHz transmit-receive separation. However, these allocation structures could allow a time division duplex (TDD) architecture by removing the distinction between subscriber unit transmit and base station transmit. In a TDD architecture, if a frequency is available, both transmit and receive functions are possible without availability concerns for the paired frequency. Furthermore, in a TDD system, duplexers are not required in the subscriber unit which could provide cost and size advantages over an FDD architecture. However, the advantages of a TDD architecture are outweighed by the advantages of an FDD architecture.[8]

The advantages of a TDD system in avoiding inter-system interference are outweighed by the additional complexity of intra-system interference avoidance. In an FDD

[8]APC has operational experience with both TDD (CT-2) and FDD (FAST-CDMA) PCS systems.

architecture, subscriber units cannot receive interference from other subscriber units and base stations cannot receive interference from other base stations. In a TDD system, all transmitting sources are potential interferors. Additional complexity in synchronization at both base stations and subscriber units is required to overcome this problem. This issue becomes more difficult to manage as the base station service area radius increases. Base station service area limitations run counter to the flexibility that should be provided to a PCS licensee to meet the demands for PCS services, particularly in the provision of PCS services to less densely populated areas.

The complexities of an FDD architecture with a variable transmit-receive separation also outweigh any spectrum sharing advantages such a system could provide. Such a system would require tunable duplexers and would provide limited benefit in an environment where PCS subscriber units are limited to spectrum blocks (20, 15 or 10 MHz) comparable to blocks occupied by incumbent microwave users (10 or 5 MHz). Such a system is beyond the scope of this report.

On balance, APC believes that the PCS allocation structure must allow for an FDD architecture with a fixed 80 MHz transmit-receive separation. The 80 MHz separation is identical to the transmit-receive separation called for by the Commission's rules for microwave users.[9] Use of an 80 MHz separation maximizes the probability that an unused channel will have the paired frequency available. Furthermore, APC's examination of the transmit-receive separations of all microwave paths in the top eleven markets has revealed that of the 1874 paths examined, 1172 paths (or 62.5%) utilize an 80 MHz transmit-receive separation. Therefore, the use of the 80 MHz separation maximizes the probability that the relocation of a microwave path will

[9]See Section 94.65 of the Commission's Rules.

make both sides of the transmit-receive pair available for PCS.

These three allocation structures specify subscriber unit transmit on the lower end of the 80 MHz separation. In general, path loss is a function of frequency; the higher the frequency, the greater the path loss. It is preferable for the reverse path (subscriber unit to base station) to have the lower propagation loss because subscriber units are usually lower-powered devices and base stations can be configured with additional receive antenna gain. Since multipath fading is highly frequency dependent, using the lower frequency on the reverse path does not guarantee that the propagation loss will be less on the reverse path. However, to the extent that there is a difference (which is recognized to be only tenths of a dB) between the path losses on the forward and reverse paths, selecting the lower frequency for subscriber unit transmit will maximize the probability that the reverse path has the lower path loss.

The three allocation structures discussed above allow a side-by-side comparison of spectrum availability for PCS systems in a shared spectrum environment. The spectrum availability comparison is also applicable to other allocation structures. As described in Section VIII below, spectrum availability maps for Licensee A, under each of the three allocation structures, are included in the tabbed sections at the back of this report. Since the spectrum availability for Licensee A is unchanged by the presence or absence of other licensees, these maps demonstrate the effect on spectrum availability of the amount of spectrum allocated per licensee, not the effect of the number of licensees per market. In this regard, for the 2 Lic/40 MHz allocation structure, the maps of spectrum availability for Licensee A are applicable to an allocation structure with 1, 2 or 3 licensees with 40 MHz per licensee. Similarly, for the 3 Lic/30 MHz allocation structure, the maps are applicable to an allocation structure with 1, 2, 3 or 4

licensees with 30 MHz per licensee, and for the 5 Lic/20 MHz allocation structure, the maps are applicable to an allocation structure with 1, 2, 3, 4 or 5 licensees with 20 MHz per licensee.

Except for spectrum limitations, the number of licensees per market is an economic issue of marketplace competition, while the amount of spectrum allocated per licensee is a technical issue of spectrum availability. The limitations on the number of licensees are set by the fact that only 140 MHz is available for licensed PCS services in the 1850 - 1990 MHz band minus spectrum allocated for unlicensed PCS services (e.g. Data PCS, wireless LAN and wireless PBX) and spectrum held in the Emerging Technologies spectrum reserve. Competition in the marketplace is an issue that involves all mobile services: cellular, ESMR, paging, unlicensed PCS, mobile data networks plus new licensed PCS operators.

This document addresses the technical issue of spectrum availability for 40, 30 and 20 MHz allocations for each PCS licensee. Specifically evaluating the 2 Lic/40 MHz, 3 Lic/30 MHz and 5 Lic/20 MHz allocation structures does allow a comparison of the number of licensees per market with respect to variability of spectrum availability between licensees, that is, whether one licensee has a much greater amount of available spectrum than a competing PCS licensee. This comparison of spectrum availability between licensees bears on the policy issue of adopting a regulatory structure for PCS that is as fair as possible.

V. Amount of Spectrum per Licensee: Access to Shared Spectrum

As demonstrated in the July 1991 Report, sufficient unused spectrum exists in the 1850-1990 MHz band for the initiation of PCS services without wholesale clearing of the

band.[10] However, technologies utilizing "avoidance" techniques to share spectrum, such as APC's FAST System, require access to an adequate amount of spectrum in order to take advantage of the unused spectrum in the band. These technologies will allow PCS licensees to "engineer" their frequency use around existing microwave licensees provided that sufficient spectrum is allocated to each PCS licensee. Having sufficient spectrum for each PCS licensee is critical to the initiation of PCS services in each market. The data and analyses presented in this report demonstrate how much spectrum is available for the immediate initiation of PCS services under each of the three allocation structures.

The amount of spectrum that is ultimately required by PCS licensees can be decided in the marketplace. In a shared spectrum environment, an allocation of spectrum for a given PCS licensee provides access to spectrum, it does not provide exclusive use. As demand for PCS services grows and additional spectrum is required, PCS licensees will need to relocate existing microwave licensees through negotiation and eventually, fully reimbursed involuntary relocation where necessary.[11] The market research of APC and others[12] indicates that there will be an extraordinarily high demand for PCS and thus, after the initiation of PCS services, incumbents will need to be relocated for additional spectrum. The relocation process allows the marketplace to decide how the spectrum should be used. The cost of relocating a microwave path, borne by the PCS licensee, will

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[10]In some locations in some markets, a few microwave licensees will need to be relocated in order to allow PCS licensees to initiate service.

[11]Even with 40 MHz per licensee, local conditions may necessitate relocating some microwave users at the outset.

[12]See Arthur D. Little, Inc., Filing to the Federal Communications Commission En Banc Hearing on Wireless Personal Communications 18 (Gen. Docket 90-314, Dec. 5, 1991).

be weighed against the value of the spectrum obtained. Therefore, the amount of spectrum ultimately required by a PCS licensee will be a marketplace decision unless arbitrarily restricted by the Commission.

VI. Technical Summary of July 1991 Report

A. Data

In order to analyze the use of the 1850-1990 MHz by OFS microwave licensees for the July 1991 Report, APC obtained complete listings of all licensed, authorized and proposed microwave stations in the band in the top eleven U.S. markets. Except for the Washington, DC data, these listings were obtained from Comsearch in late April or early May of 1991 and then updated later in May, 1991. The Washington, DC data were originally obtained from Comsearch in February 1991 to verify information from the FCC Non-Government Frequency Master List microfiche dated January 1990. Those data were further verified by frequency coordination as part of APC's experimental activities in the Washington/Baltimore area.

B. Microwave Path Statistics

The July 1991 Report provided an analysis of the microwave usage of the 1850-1990 MHz band. This analysis included number of paths, microwave path lengths and the distribution of microwave transmitters relative to the city reference coordinates. The results of this detailed analysis were provided in Volume II of the July 1991 Report.

C. Grid Points

In addition to the analysis of microwave usage of the 1850-1990 MHz band, the July 1991 Report also contained the Spectrum Sharing Analysis. In order to evaluate spectrum availability across a market area, a grid of points 30 minutes high (latitude) by 30 minutes wide (longitude) was overlaid on each market, centered on the city reference coordinates. Each grid consisted of 625 points (25 by 25) spaced 1.25 minutes apart. Depending on the latitude of the city, each grid covered an area approximately 34 miles high by 26 miles wide, or approximately 884 square miles. PCS spectrum availability was evaluated at each grid point (grid points coinciding with major bodies of water were inactivated and were not considered in the analysis).

D. Bins

In order to evaluate spectrum availability at each grid point, the 1850-1990 MHz band was divided into 2.5 MHz bins. The 2.5 MHz bin size was utilized because of the 5 MHz interstitial OFS microwave channels. This subdivision of the band allows preclusion of PCS usage of cochannel and adjacent channel frequencies in the proximity of microwave receivers.[13] In the July 1991 Report, all bins were initially available for PCS at each grid point. The microwave protection analysis then removed certain bins from the list of available bins at certain grid points in accordance with the cochannel and adjacent channel interference protection criteria. At the conclusion of the microwave protection analysis, the computer program reported the bins remaining available for PCS use at each grid point.

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[13]Bin 1 is 1850 to 1852.5 MHz, bin 2 is 1852.5 to 1855 MHz, etc. See July 1991 Report, pages 10 - 12.

E. Exclusion Zones

In order to provide interference protection to microwave receivers, cochannel and adjacent channel exclusion zones were established for every microwave station in the database. APC does not advocate that operating PCS systems use simple exclusion zones to provide interference protection to OFS microwave licensees.[14] Exclusion zones are a useful device for obtaining valuable information on spectrum sharing which can be used for policy decisions. The exclusion zones utilized in the July 1991 Report are not flexible enough to be utilized for actual PCS system design nor were they intended to be put to this type of use.

The cochannel exclusion zone used in the July 1991 Report had three components. The first was an absolute minimum distance from the microwave station. This meant that any grid point within 4.0 miles of the microwave station, in any direction, was in the cochannel exclusion zone. The second component was the minimum distance on the "front" side of the receive antenna. Any grid point within 25.75 miles of the microwave station was in the exclusion zone, provided that it was within the main lobe of the receive antenna. The third component was the width of the main lobe. The width utilized in the July 1991 Report was 5 degrees on either side of the direct path from the receive antenna to its associated transmitting antenna. This provides a total beamwidth of 10 degrees.

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[14]In fact, APC has developed its FAST System, which combines theoretical interference analyses with measured data to control PCS frequency use to allow PCS systems and OFS facilities to share the 1850-1990 MHz band without mutual interference. APC completed its first phase of field testing of the FAST system on April 24, 1992. APC commenced the second phase of FAST system field testing on October 5, 1992 with the deployment of its FAST-CDMA system using Qualcomm's CDMA technology.

Similarly, the adjacent channel exclusion zone used an absolute minimum distance of 1.6 miles, a minimum "front" side distance of 14.9 miles and a total beamwidth of 10 degrees.

The July 1991 Report provided detailed information concerning the derivation of the values used for the exclusion zone components. The assumptions and calculations utilized to determine the size of the cochannel and adjacent channel exclusion zones were based on sound engineering practices and resulted in reasonable and supportable exclusion zones. After more than a year of scrutiny, the exclusion zones utilized in the July 1991 Report remain valid for their intended purpose.

In each market included in the study, the computer program developed by APC for the July 1991 Report examined each microwave station in the database. For each microwave station, each grid point was examined to see if it was within the cochannel exclusion zone. If so, bins cochannel with the microwave station's receive frequency were removed from the list of bins available for PCS at that grid point. Similarly, each grid point was examined to see if it was within the adjacent channel exclusion zone. If it was, bins adjacent to the microwave station's receive frequency were removed from the list of bins available for PCS at that grid point. For a 10 MHz OFS microwave channel, two bins above and two bins below the channel were considered adjacent. For a 5 MHz OFS microwave channel, one bin above and one bin below the channel were considered adjacent.

F. Spectrum Availability

At the conclusion of the study, for each city the computer program reported the bins remaining available for PCS at each grid point. This detailed output was provided in Volume II of the July 1991 Report.

The July 1991 Report provided spectrum availability maps for each of the eleven markets included in the study. These maps provided a visual indication of the availability of spectrum for PCS across the grid area in each market. In addition to the maps, the July 1991 Report provided some conclusions about spectrum availability. The most important conclusion contained in the report was,

> "Over 96% of the grid locations across the eleven markets have at least 50 MHz available for start-up PCS operations."[15]

VII. Technical Summary of Present Report

The present report is intended to supplement the July 1991 Report. In general, this report utilizes the same methodology as the July 1991 Report with some important modifications. Specifically, the present report evaluates PCS spectrum availability for each PCS licensee under the three allocation structures described in Section IV above. A comparison of the methodologies used for this report and the July 1991 Report is outlined below.

A. Data

The OFS microwave data, with the exception of the Washington, DC data[16], are identical to the data utilized in the July 1991 Report. Although these data are approximately 18 months old, the OFS microwave environment is relatively

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[15]See July 1991 Report, page 22.

[16]APC has continued to verify and update the OFS microwave data for Washington, DC through direct frequency coordination as part of its experimental activities in the Washington/Baltimore area.

static and remains substantially unchanged. Although some microwave paths have been modified, added and deleted since the last data update, the analyses contained in this report are not intended for specific PCS system design in each market. Rather, the analyses are intended to provide information to support policy decisions concerning PCS allocations and therefore, the data utilized are sufficient for the intended purpose. The top eleven markets have been utilized since it is believed that licensed PCS services must be viable in the top U.S. markets in order to reach the projected market penetrations.

B. Grid Points

This report utilizes the same grid points as were utilized in the July 1991 Report. APC is not proposing that these grid points are co-extensive with the PCS service areas. They are used for illustrative purposes, and are valid and reliable for that purpose. The grid points are a convenient method of evaluating PCS spectrum availability across a market area. Since the grids are centered on the city reference coordinates, they do contain the downtown areas which are expected to be the areas of highest PCS subscriber density.

C. Bins

This report utilizes the same subdivision of the 1850-1990 MHz band into 2.5 MHz bins as the July 1991 Report. However, the computer program developed for the July 1991 Report initially made all bins available for PCS at each grid point prior to the microwave protection analysis. The computer program utilized for this report examines spectrum availability for each PCS licensee and therefore initially makes only those bins that are appropriate for the specific licensee under the specific allocation structure available

for PCS prior to the microwave protection analysis. For the July 1991 Report, bins 1 through 56 (1850 through 1990 MHz) were initially made available for PCS at each grid point. For this report, under the 3 Lic/30 MHz allocation structure, for example, only bins 1 through 6 (1850 through 1865 MHz) and bins 33 through 38 (1930 through 1945 MHz) are initially made available for PCS Licensee B.

The July 1991 Report evaluated spectrum availability assuming that the entire 1850-1990 MHz band would be allocated for licensed PCS services. This report examines spectrum availability for each licensee under the three allocation structures listed in Section IV above. Under each of the three allocation structures 20 MHz is allocated for unlicensed PCS services and some spectrum is held in reserve. Therefore, this report provides a refinement to the spectrum availability analysis contained in the July 1991 Report.

The July 1991 Report did not assume an FDD architecture with a fixed 80 MHz transmit-receive separation. In this report, as discussed in Section IV above, if either side of the frequency pair is unavailable at a given grid point, both sides are removed from the available frequency list for that grid point.[17] This is a further refinement to the spectrum availability analysis contained in the July 1991 Report.

D. Exclusion Zones

This report utilizes the same exclusion zones that were used for the July 1991 Report.

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[17]This becomes a factor in PCS frequency availability for grid points in the proximity of microwave paths using non-standard transmit-receive separations.

E. Microwave Relocation

This report examines spectrum availability for each PCS licensee under each allocation structure under four microwave relocation assumptions. First, spectrum availability is determined for each licensee assuming no microwave links have been relocated. As part of that analysis, the computer program ranks the microwave paths in terms of preclusionary impact on frequency availability for that PCS licensee. The "worst case" microwave path is then assumed to be relocated out of the 1850-1990 MHz band (removed from the OFS database) and spectrum availability is then re-evaluated for that PCS licensee. This process is then repeated assuming the two worst case paths are relocated and finally spectrum availability is evaluated a fourth time, assuming the three worst case paths have been relocated.

The determination of "worst case" microwave link is made by ranking the microwave paths by total number of bins precluded. For each microwave station, a running total of bins precluded from PCS use is made across all grid points. The preclusionary impact of the microwave link is the sum of the bins precluded by the stations on each side of the link. The microwave path with the highest total number of bins precluded is ranked first, the link with the next highest total is ranked second and so on.

This method of selecting the "worst case" microwave paths for relocation is reasonable, although it may not reflect the order in which a PCS licensee actually relocates incumbent users. This "worst case" determination identifies microwave paths that are blocking significant amounts of spectrum for PCS use, but relocating these paths in this particular order may not "free up" spectrum in a particular area where it may be needed. Furthermore, some paths may be easier to relocate for business or technical reasons; even though they may not be the worst case paths, they may be

relocated first. These marketplace considerations in the negotiation and relocation process are not included in this analysis. In particular, distinctions between paths licensed to entities (state and local government)[18] that are exempt from mandatory relocation and those licensed to non-exempt entities are not made in this analysis.

The evaluation of spectrum availability under microwave relocation scenarios was not extended beyond each PCS licensee relocating the three "worst case" links. This limit was selected to be consistent with the approach to spectrum sharing advocated by APC to allow prompt initiation of PCS services,

> "...[S]ufficient unused spectrum in the 1850-1990 MHz band exists to allow immediate initiation of PCS services -- using available technology and with no need to clear the entire 1850-1990 MHz band."[19]

APC has recognized that in some locations in some markets, microwave links need to be relocated to allow for the initiation of PCS services. Selecting zero to three "worst case" microwave relocations by each PCS licensee is a reasonable interpretation of APC's spectrum sharing proposals.

The greater the number of microwave paths requiring relocation, the greater the delay in the initiation of PCS services and the greater the cost to the PCS licensee and, therefore, to the American consumer. Freeing up microwave frequencies by relocation will require substantial time and commitment of resources. The process involves negotiation, identification of available alternate frequencies, design of

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[18]See Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, First Report & Order, FCC 92-437 (ET Docket 92-9, Oct. 16, 1992).

[19]See Executive Summary, July 1991 Report, page 1.

technical facilities, FCC licensing, zoning and permitting (including FAA clearances where necessary), equipment purchase, installation, acceptance testing and finally cut-over to the new microwave facilities. Each of the steps in this process involves significant costs.

Three microwave link relocations per PCS licensee would create between 6 and 15 relocations per market depending on the number of PCS licensees. Multiplied by the number of PCS markets, that number of relocations could strain the industry's financial and technical resources, microwave equipment manufacturer's resources and even the Commission's application processing resources. Therefore, structuring PCS spectrum allocations on the premise that PCS licensees will need to relocate as many as three microwave licensees per market prior to initiation of PCS services would lead to significant delays and could prevent the PCS industry from achieving its full potential.

As discussed in greater detail in Section VIII below, in the most frequency congested markets, each PCS licensee needs to relocate more than 3 microwave links before PCS service can be provided throughout the market area. This is true even under the 2 Lic/40 MHz allocation structure which provides the maximum amount of spectrum per licensee. The less spectrum allocated per PCS licensee, the greater the percentage of area in the congested markets without any available spectrum. In the least congested markets, fewer microwave links need to be relocated before PCS service can be provided throughout the market area.

The evaluation of spectrum availability under microwave relocation assumptions is a further refinement to the July 1991 Report.

VIII. Results of Computer Analysis

The computer program utilized for this study generated a tremendous amount of data. Without consideration of averaging and other statistics, the program generated data to graphically depict the amount of spectrum available at each grid point in each market, for each PCS licensee, under each of the allocation structures, under each microwave relocation assumption. This data alone was sufficient to produce 440 spectrum availability maps. Some data reduction was necessary to avoid overwhelming the reader with information and obscuring the meaningful results.

A. Charts and Maps

The amount of spectrum actually <u>available</u> for a PCS licensee in a shared spectrum environment is a function of the amount of spectrum <u>allocated</u> for each PCS licensee. The tabbed sections in the back of this report provide information in two forms to assist in analyzing this relationship -- charts and maps. Each tabbed section represents information pertinent to a particular market.

Two charts are provided for each market. The first chart shows the percentage of market area with no spectrum available for PCS for each PCS licensee under each of the allocation structures, assuming no microwave paths have been relocated. The red and green bars in the left hand group indicate the percentage of area with no spectrum available for Licensees A and B under the 2 Lic/40 MHz allocation structure. Similarly, the red, green and blue bars in the center group indicate the percentage of area with no spectrum available for Licensees A, B and C under the 3 Lic/30 MHz allocation structure. Finally, the red, green, blue, yellow and purple bars in the right hand group indicate the percentage of area with no spectrum available

for Licensees A, B, C, D and E under the 5 Lic/20 MHz allocation structure.

The second chart demonstrates the impact of microwave relocation on the percentage of area with no spectrum available. The first chart provided the percentage of market area with no spectrum available for PCS for each PCS licensee under each of the allocation structures assuming no microwave paths have been relocated. This second chart provides the same information under the assumptions that 0, 1, 2 and 3 "worst case" microwave paths have been relocated. The four sets of red and green bars on the left hand side indicate the percentage of area with no spectrum available for Licensees A and B under the 2 Lic/40 MHz allocation structure. The bars above the "0" are identical to those on the first chart. The bars above the "1" show spectrum availability assuming the worst case microwave link has been relocated, the bars above the "2" show spectrum availability assuming the two worst case microwave links have been relocated, and so on. As is to be expected, the percentages of areas with no spectrum available decrease as microwave links are relocated.

Four tables are provided at the conclusion of this report text, prior to the tabbed sections. These tables provide the values that are graphically displayed on the charts. The first table provides the percentages of areas with no spectrum available for each PCS licensee under each allocation structure assuming no microwave relocations. The second table provides the same information assuming one "worst case" microwave link has been relocated, and so on.

In New York for example, for Licensee A, only 11.8% of the area has no spectrum available under the 2 Lic/40 MHz allocation structure. The percentage of area with no spectrum available for Licensee A increases to 23.7% under the 3 Lic/30 MHz allocation structure and reaches 40.4% under the 5 Lic/20 MHz allocation structure. This means that under the 5 Lic/20 MHz allocation structure, Licensee A